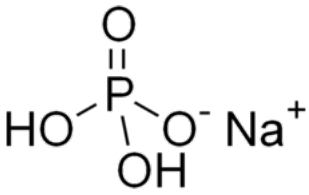
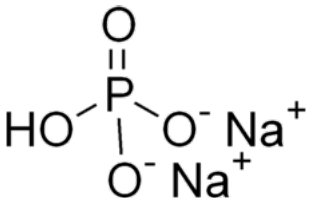
Sodium phosphate

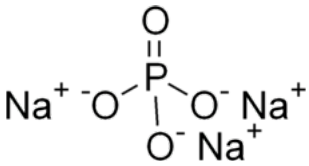
A **sodium phosphate** is a generic variety of salts of sodium (Na^+) and phosphate (PO_4^{3-}). Phosphate also forms families or condensed anions including di-, tri-, tetra-, and polyphosphates. Most of these salts are known in both anhydrous (water-free) and hydrated forms. The hydrates are more common than the anhydrous forms.[1]



Sodium dihydrogen phosphate



Sodium hydrogen phosphate



Trisodium phosphate

Uses

Sodium phosphates have many applications in food and for water treatment. For example, sodium phosphates are often used as emulsifiers (as in processed cheese),[2] thickening agents, and leavening agents for baked goods. They are also used to control pH of processed foods.[3] They are also used in medicine for constipation and to prepare the bowel for medical procedures. They are also used in detergents for softening water and as an efficient anti-rust solution.

Adverse effects

Sodium phosphates are popular in commerce in part because they are inexpensive and because they are nontoxic at normal levels of consumption.[4] However, oral sodium phosphates when

taken at high doses for bowel preparation for colonoscopy may in some individuals carry a risk of kidney injury under the form of phosphate nephropathy. There are several oral phosphate formulations which are prepared extemporaneously. Oral phosphate prep drugs have been withdrawn in the United States, although evidence of causality is equivocal.[5] Since safe and effective replacements for phosphate purgatives are available, several medical authorities have recommended general disuse of oral phosphates.[6]

Monophosphates

Three families of sodium monophosphates are common, those derived from orthophosphate (PO_4^{3-}), hydrogen phosphate (HPO_4^{2-}), and dihydrogenphosphate ($H_2PO_4^-$). Some of the best known salts are shown in the following table.

name	formula	CAS registry number
monosodium phosphate (anhydrous)	NaH_2PO_4	7558-80-7
monosodium phosphate monohydrate	$NaH_2PO_4 \cdot H_2O$	10049-21-5
monosodium phosphate dihydrate	$NaH_2PO_4 \cdot 2H_2O$	13472-35-0
disodium phosphate (anhydrous)	Na_2HPO_4	7558-79-4
disodium phosphate dihydrate	$Na_2HPO_4 \cdot 2H_2O$	10028-24-7
disodium phosphate heptahydrate	$Na_2HPO_4 \cdot 7H_2O$	7782-85-6
disodium phosphate octahydrate	$Na_2HPO_4 \cdot 8H_2O$	
disodium phosphate dodecahydrate	$Na_2HPO_4 \cdot 12H_2O$	10039-32-4
trisodium phosphate (anhydrous, hexagonal)	Na_3PO_4	
trisodium phosphate (anhydrous, cubic)	Na_3PO_4	7601-54-9
trisodium phosphate hemihydrate	$Na_3PO_4 \cdot 0.5H_2O$	
trisodium phosphate hexahydrate	$Na_3PO_4 \cdot 6H_2O$	
trisodium phosphate octahydrate	$Na_3PO_4 \cdot 8H_2O$	
trisodium phosphate dodecahydrate	$Na_3PO_4 \cdot 12H_2O$	10101-89-0

Di- and polyphosphates

In addition to these phosphates, sodium forms a number of useful salts with pyrophosphates (also called diphosphates), triphosphates and high polymers. Of these salts, those of the diphosphates are particularly common commercially.

name	formula	CAS Registry number
monosodium diphosphate (anhydrous)	$NaH_3P_2O_7$	
disodium diphosphate (anhydrous)	$Na_2H_2P_2O_7$	7758-16-9
disodium diphosphate hexahydrate	$Na_2H_2P_2O_7 \cdot 6H_2O$	
trisodium diphosphate (anhydrous)	$Na_3HP_2O_7$	
trisodium diphosphate monohydrate	$Na_3HP_2O_7 \cdot H_2O$	
trisodium diphosphate nonahydrate	$Na_3HP_2O_7 \cdot 9H_2O$	
tetrasodium diphosphate (anhydrous)	$Na_4P_2O_7$	7722-88-5
tetrasodium diphosphate decahydrate	$Na_4P_2O_7 \cdot 10H_2O$	13472-36-1

Beyond the diphosphates, sodium salts are known triphosphates, e.g. sodium triphosphate and tetraphosphates. The cyclic polyphosphates, called metaphosphates, include the trimer sodium trimetaphosphate and the tetramer, $Na_3P_3O_9$ and $Na_4P_4O_{12}$, respectively.

Polymeric sodium phosphates are formed upon heating mixtures of NaH_2PO_4 and Na_2HPO_4, which induces a condensation reaction. The specific polyphosphate generated depends on the details of the heating and annealing. One derivative is the glassy (i.e., amorphous) **Graham's salt** (sodium hexametaphosphate). It is a cyclic polyphosphate with the formula $Na_6[(PO_3)_6]$. Crystalline high molecular weight polyphosphates include **Kurrol's salt** and **Maddrell's salt** (CAS#10361-03-2). These species have the formula $[NaPO_3]_n[NaPO_3(OH)]_2$ where *n* can be as great as 2000, and it is a white powder practically insoluble in water. In terms of their structures, these polymers consist of PO_3^- units, with the chains are terminated by protonated phosphates.[1] [7]

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